

SUSTAINABLE USE AND CONSERVATION OF WATER RESOURCES IN THE GANJA PHYSICAL-GEOGRAPHICAL REGION

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Summary. The study examines the sustainable use and conservation of water resources in the Ganja Physical-Geographical Region under increasing water demand and climate-related pressures. The region possesses a diverse hydrographic network consisting of mountain rivers, lakes, reservoirs, groundwater, and springs that support drinking-water supply, agriculture, industry, recreation, and ecosystem functioning. Most rivers originate on the northeastern slope of the Lesser Caucasus and belong to the Kura River basin; with the exception of Aghstafachay, they are generally less than 100 km long. The study shows that river flow is extensively used for irrigation and is regulated by reservoirs and hydraulic structures, while mountain lakes, particularly those within Goygol National Park, constitute important freshwater and ecological resources. At the same time, seasonal water scarcity, inefficient irrigation, pollution, and increasing demand create significant pressures on regional water resources. Sustainable management therefore requires the wider application of water-saving irrigation technologies, improved flow and water-quality monitoring, control of wastewater discharge, protection of groundwater and river corridors, and conservation of water bodies within protected areas. These measures are essential for maintaining the long-term ecological and socioeconomic functions of the region's water resources.

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Introduction

Sustainable use and conservation of water resources have become increasingly important under the growing impacts of climate change and rising water demand. This issue is particularly relevant for Azerbaijan, where water resources are relatively limited and their efficient management is essential for maintaining water supply, agricultural production, and ecological stability.

The Ganja Physical-Geographical Region encompasses the northeastern slope of the Lesser Caucasus and its foothill plains and is characterized by a relatively dense hydrographic network. Its water resources consist primarily of mountain rivers originating in the Murovdagh and Shahdagh ranges, together with groundwater, springs, lakes, and reservoirs. Most rivers belong to the Kura River basin and flow as right tributaries of the Kura. These resources play an important role in drinking-water supply, irrigation, industry, and the functioning of regional ecosystems.

Accordingly, the study focuses on the spatial and hydrological characteristics of the region's principal water resources, their current patterns of use, major environmental pressures, and measures required for their sustainable management and conservation.

Analysis and discussion

The rivers of the Ganja Physical-Geographical Region belong to the Kura River basin and are fed mainly by snow, rainfall, and groundwater. Stable groundwater recharge plays an important role in the annual runoff regime, while relief, geological structure, soil and vegetation cover, basin morphology, lake coverage, wetland conditions, and glaciation influence runoff formation (Mammadov, 2012).

The river network is unevenly distributed across the region and varies considerably with elevation. Drainage density generally increases toward mountainous areas and is particularly high in the middle-mountain zone, where most rivers originate. However, this relationship is also controlled by precipitation and other local physical-geographical conditions. Surface water and groundwater together determine the regional water-resource potential, while the relative contribution of individual alimentation sources is reflected in the hydrological regime (*Constructive Geography of the Republic of Azerbaijan*, 1996–1999).

Rivers constitute the principal component of the region's water resources. With several exceptions, including Aghstafachay and Hasansuchay, most originate within the Azerbaijani part of the Lesser Caucasus and are extensively used for irrigation, domestic water supply, and other economic purposes.

Hasansuchay originates in the Murguz Range of the Lesser Caucasus and is a transit river fed mainly by snow and groundwater. Its lower reaches carry significant flow primarily during periods of heavy precipitation because its water is extensively used for irrigation. Summer floods, particularly in June and July, coincide with high agricultural water demand, emphasizing the need for efficient use while maintaining sufficient downstream flow (Museyibov, 1998).

Aghstafachay, another transit river, originates in the Pambak Range and is fed by groundwater, snowmelt, and rainfall. Its flow is regulated by a reservoir and is extensively used for irrigation. The river generally maintains a high-flow regime until the end of June, providing favorable conditions for seasonal water use.

Akhynchachay originates near the Bashkent Pass of the Kecheldagh Range. Its water resources are particularly important during summer, when heavy rainfall can increase discharge in July (Ayyubov & Hajiyev, 1984). A reservoir regulates its flow for irrigation. Its tributary Tovuzchay, originating in the Murguz Range, is also a transit river and is regulated by the Khatinli Reservoir. More than four main canals withdraw water for irrigation, while upstream water use reduces the flow entering Azerbaijan. The river is also exposed to pollution associated with industrial activities within its basin.

Asrikchay, a right tributary of Akhynchachay, is formed by small spring-fed rivers originating in the Shahdagh Range. Rainfall and groundwater constitute its principal sources of alimentation. The river has hydrorecreational importance and is also intensively used for irrigation through five main canals.

Zayamchay originates on the northern slope of the Shahdagh Range at the confluence of Shakarbaychay and Chatindara rivers and drains parts of Shamkir, Tovuz, and Gadabay districts. It is fed by groundwater, rainfall, and snowmelt and is characterized by a spring high-water regime. Its irrigation use is supported by small hydraulic structures that regulate river discharge.

Shamkirchay is one of the region's most important rivers. It originates on the northeastern slope of the Shahdagh Range at the confluence of Sarisu and Aghdashsu rivers. Goygol, situated at an elevation of 2,470 m, contributes to the Shamkirchay system through one of the Sarisu tributaries, and its regulated outflow provides additional water during periods of intensive irrigation. Shamkirchay is also connected with Ganjachay by an irrigation canal and has important irrigation, hydrorecreational, and ecological functions (Mammadov, 2012).

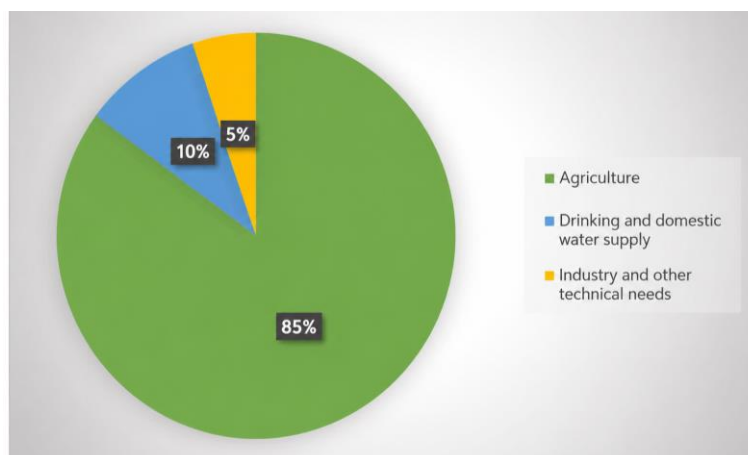


Fig. 1. Distribution of Shamkirchay River water use by sector (%).

Goshgarchay originates on the northern slope of Mount Goshgar in the Murovdagh Range and is formed by the confluence of Khoshbulag and Hamamchay, the latter being supplied by permanent springs. Its upper basin has a dense river network. Although its water is used in agriculture and industry, contamination by mining waste restricts its effective use.

The water resources of other rivers of the Ganja Physical-Geographical Region, including Ganjachay, Goranchay and Incechay, are also used for irrigation. The Rasul and Khan channels have been constructed from Ganjachay, supplying water for irrigation around Ganja. More than seven channels withdraw water from Goranchay for irrigation of surrounding areas. The water of Incechay does not reach the Kura River because it is fully utilized; more than five main canals withdraw water from the river. Analysis of the hydrological characteristics and sustainable use of Aghsuchay and Kurekchay shows that several lakes were formed in the Aghsuchay valley as a result of earthquakes. The largest of these lakes is Goy-Gol. Kurekchay is formed by the confluence of three rivers—Ilkhdara, Omerchay and Banovshachay. Hydrologically, Ilkhdara is regarded as the principal river. Kurekchay flows into the Kura River downstream of the Mingachevir Reservoir. Because rural settlements are located along the river, its water is widely used for irrigation.



Fig. 2. Ganjachay River (Topalhasanlı village).

A portion of the water resources of the Ganja Physical-Geographical Region is concentrated in lakes. As noted above, landslide-dammed lakes were formed when the collapse of Mount Kapaz during an earthquake blocked the course of Aghsuchay. The picturesque mountain lakes Goygol, Maralgol, Zeligol, Shamligol and others are located within forest and subalpine meadow zones and constitute freshwater sources. The lakes are distinguished by their transparency, with visibility reaching depths of approximately 13 m. Because Goygol has an outlet, its water is used as a source of freshwater.

In the vicinity of Mount Kapaz in the Ganja Physical-Geographical Region, in addition to Goygol, there are Maralgol, Zeligol, Ordekgol, Shamligol, Aynagol, Garagol, Jeyrangol, Ayigol, Chiligol and Qushgol. All of these lakes are freshwater bodies. They have exceptional economic importance within the ecological-recreational system and water-resource balance of the physical-geographical region. The lakes are used sustainably for various purposes and constitute the area's greatest tourism and recreation potential. These lakes are located within Goygol National Park. Their therapeutic and recreational significance is considerable. Because the lakes are situated in mountain-forest and subalpine meadow zones, the area is characterized by clean, oxygen-rich air and a cool microclimate. Mountain lakes are sources of clean, high-quality freshwater and also play a major role in river alimentation (N. N. Hajiyeva, *Economic-Geographical Assessment of the Natural Conditions and Resources of Azerbaijan*, Ganja, 2025, p. 178, Star Printing House).

The Ayigol, Chiligol and Qushgol (Ordekgol) lakes were formed when landslides caused by the Ganja earthquake blocked river valleys. Ayigol is a small freshwater lake located at the intersection of dense mountain forests and meadow zones. According to the results of the studies, the lake was named in connection with the presence of mountain fauna, particularly Caucasian brown bears, which found shelter in the surrounding forests and came to the area to drink water. Chiligol, located in Goygol National Park, is one of the small lakes. Its water is shallow and relatively marshy. It is called Chiligol because dense aquatic vegetation, including reeds and other wetland plants, grows both on its surface and underwater.



Fig. 3. Goygol Lake.

Among the small lakes in the Goygol and Maralgol basins, Qushgol (Duck Lake) was formed as a result of an earthquake. It received this name because various species of mountain and aquatic birds, particularly ducks, are abundant around and on the water.

All three lakes are fed mainly by snow, rainfall and springs. Their water is cold and transparent. They are located within Goygol National Park and are of considerable importance as water resources.

It should be noted that rivers originating from the lakes or enriched by their outflow play a major role in supplying settlements in the Ganja–Goygol area with drinking water. Lakes are highly important for regulating groundwater in the Ganja Physical-Geographical Region. They contribute to maintaining a continuous supply of water to springs and groundwater in surrounding areas. The hydrographic network formed by these lakes is vital for agriculture in foothill and lowland areas. During the summer irrigation season, lake water resources are intensively utilized. Water from rivers flowing out of the lakes is used to irrigate cultivated lands in Ganja, Dashkasan and Goygol districts.

The Shamkir Reservoir, which concentrates a portion of the water resources of the Ganja Physical-Geographical Region, receives the inflow of up to seven small rivers and contains up to four small lakes within its basin. Since 1956, the lake has functioned as an artificial water body and has been used to regulate the flow of Shamkirchay. It is an outflowing freshwater body.

The lakes located in the Ganja Physical-Geographical Region regulate air humidity within the mountain-forest ecosystem, moderate the microenvironment and function as natural reservoirs that help prevent soil erosion. Since the lakes mentioned above are included within specially protected natural areas, their economic use is primarily carried out within the framework of protected ecotourism, scientific research and sustainable water supply.

As shown in Table 1, water resources are used most extensively for domestic purposes, agriculture and industrial activities.

Over the past century, significant changes have been observed in various components of natural conditions. Excessive exploitation of natural resources, particularly water resources, as well as inefficient use of these resources, has contributed to the emergence of various problems. The conservation of water resources is therefore extremely important under present conditions and constitutes a foundation of environmental policy (Sh. Goychayli and Telman Ismayilov, *Economic and Environmental Foundations of Nature Management*, MBM, 2009).

The Ganja Physical-Geographical Region is among the areas with a relatively high population density. Adequate water supply and good water quality are highly important for human health and agricultural development. Excessive use of water resources can lead to water losses in some locations, particularly in depressed areas of the relief. Sanitary protection zones should therefore be established around water sources to conserve water and improve its environmental quality.

Table 1

Sustainable use and conservation of the water resources of Ganjachay and Goshgarchay

Water resource / problem	Area of use	Main threat	Sustainable use and conservation measure
Ganjachay	Irrigation, domestic and economic use	Pollution, seasonal decline in water availability	Wastewater treatment, water conservation, and establishment of riparian protection zones
Goshgarchay	Water management and ecosystem	Seasonal decline in water availability and pollution	Flow monitoring and control of wastewater discharge
Groundwater	Drinking water and domestic use	Over-abstraction and pollution	Setting limits on water abstraction and conducting regular hydrogeological monitoring
Irrigation water	Agriculture	Water wastage and losses	Application of drip and sprinkler irrigation systems
River ecosystems	Biodiversity and ecological balance	Domestic and industrial waste	Prevention of waste discharge into rivers and strengthening environmental control
Overall water-resource management	Population and economic activity	Increasing aridity and water scarcity	Calculation of the water balance, water reuse, and public awareness

Constant attention should be paid to the maintenance and repair of the small water-regulating reservoirs constructed within the physical-geographical region. Otherwise, prolonged use may lead to water leakage from reservoirs. Population growth and increasing water demand are observed every year. Although water has traditionally been regarded as a renewable resource, there is a growing concern regarding the depletion of drinking-water resources. Water resources play an indispensable role in regulating the natural conditions and ecological processes of the physical-geographical region. Their most important ecological function is their participation in photosynthesis. Due to its multifunctional properties, water contributes to the formation of natural conditions and is regarded as an indispensable natural resource for meeting human needs.

Conclusion

The water resources of the Ganja Physical-Geographical Region are of major importance in terms of the area's natural conditions, the domestic needs of the population and agricultural development.

- The principal objective of sustainable water-resource use is to ensure that the quality and quantity of existing water resources are preserved for future generations while they are being utilized.
- In agriculture, it is necessary to reduce water losses, particularly losses in irrigation systems and canals, and to widely apply water-saving technologies.
- Pollution of Ganjachay and other water bodies in the Ganja Physical-Geographical Region should be prevented, particularly by preventing the discharge of domestic and industrial waste into rivers.
- Protective zones should be established along riverbanks, and regular environmental monitoring should be conducted.
- Particular attention should be paid to the protection of groundwater in the region. Excessive groundwater abstraction reduces reserves, while pollution creates problems for drinking-water supply.
- Among the water resources of the Ganja Physical-Geographical Region, Shamkirchay, Tovuzchay and Asrikchay are of particular importance and occupy an important position in the water-resource system. Water quality should be monitored to ensure the sustainable use of these rivers.

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РАЦИОНАЛЬНОЕ ИСПОЛЬЗОВАНИЕ И ОХРАНА ВОДНЫХ РЕСУРСОВ ГЯНДЖИНСКОГО ФИЗИКО-ГЕОГРАФИЧЕСКОГО РАЙОНА

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Резюме. В исследовании рассматриваются вопросы устойчивого использования и охраны водных ресурсов Гянджинского физико-географического района в условиях возрастающей потребности в воде и усиления воздействия факторов, связанных с изменением климата. Район характеризуется разнообразной гидрографической сетью, включающей горные реки, озёра, водохранилища, подземные воды и родники, которые играют важную роль в обеспечении питьевого водоснабжения, сельского хозяйства, промышленности, рекреационной деятельности и функционирования экосистем. Большинство рек берёт начало на северо-восточном склоне Малого Кавказа и относится к бассейну реки Куры. За исключением Агстафачая, их протяжённость, как правило, составляет менее 100 км. Результаты исследования показывают, что речной сток широко используется для орошения и регулируется посредством водохранилищ и гидротехнических сооружений. Вместе с тем горные озёра, особенно расположенные на территории Гейгёльского национального парка, представляют собой важные ресурсы пресной воды и имеют значительную экологическую ценность. Одновременно сезонный дефицит воды, неэффективное использование водных ресурсов в оросительных системах, загрязнение и растущий спрос на воду создают существенную нагрузку на водные ресурсы региона. В связи с этим устойчивое управление водными ресурсами требует более широкого внедрения водосберегающих технологий орошения, совершенствования мониторинга речного стока и качества воды, усиления контроля за сбросом сточных вод, охраны подземных вод и приречных территорий, а также сохранения водных объектов в пределах особо охраняемых природных территорий. Реализация указанных мер имеет важное значение для долгосрочного сохранения экологических и социально-экономических функций водных ресурсов исследуемого района.

Ключевые слова: Гянджинский физико-географический район, водные ресурсы, реки, озёра, водохранилища, подземные воды, устойчивое управление водными ресурсами

GƏNCƏ FİZİKİ-COĞRAFI RAYONUNUN SU EHTİYATLARINDAN DAYANIQLI İSTİFADƏ VƏ ONLARIN QORUNMASI

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Xülasə. Tədqiqatda suya tələbatın artması və iqlim dəyişmələri ilə əlaqədar təzyiqlərin güclənməsi şəraitində Gəncə fiziki-coğrafi rayonunun su ehtiyatlarından davamlı istifadə və onların mühafizəsi məsələləri araşdırılmışdır. Rayon içməli su təchizatı, kənd təsərrüfatı, sənaye, rekreasiya və ekosistemlərin fəaliyyəti üçün mühüm əhəmiyyət daşıyan dağ çayları, göllər, su anbarları, yeraltı sular və bulaqlardan ibarət zəngin və müxtəlif hidroqrafik şəbəkəyə malikdir. Çayların əksəriyyəti Kiçik Qafqazın şimal-şərq yamacından başlanır və Kür çayı hövzəsinə aiddir. Ağstafaçay istisna olmaqla, onların uzunluğu əsasən 100 km-dən azdır. Tədqiqat göstərir ki, çay sularından suvarma məqsədilə geniş istifadə olunur və onların axımı su anbarları və hidrotexniki qurğular vasitəsilə tənzimlənir. Bununla yanaşı, dağ gölləri, xüsusilə Göygöl Milli Parkının ərazisində yerləşən göllər mühüm şirin su mənbələri və ekoloji ehtiyatlar hesab olunur. Eyni zamanda, mövsümi su çatışmazlığı, suvarma sistemlərində sudan səmərəsiz istifadə, çirklənmə və suya tələbatın artması regionun su ehtiyatlarına ciddi təzyiq göstərir. Buna görə də su ehtiyatlarının davamlı idarə olunması suya qənaət edən suvarma texnologiyalarının daha geniş tətbiqini, çay axımı və suyun keyfiyyəti üzrə monitorinqin təkmilləşdirilməsini, tullantı sularının axıdılmasına nəzarətin gücləndirilməsini, yeraltı suların və çayboyu ərazilərin mühafizəsini, eləcə də xüsusi mühafizə olunan təbiət ərazilərində yerləşən su obyektlərinin qorunmasını tələb edir. Bu tədbirlərin həyata keçirilməsi rayonun su ehtiyatlarının ekoloji və sosial-iqtisadi funksiyalarının uzunmüddətli qorunub saxlanılması baxımından mühüm əhəmiyyət kəsb edir.

Açar sözlər: Gəncə fiziki-coğrafi rayonu, su ehtiyatları, çaylar, göllər, su anbarları, yeraltı sular, su ehtiyatlarının dayanıqlı idarə edilməsi